

Claims

- [c1] 1. A method of acquiring free-breathing MR images comprising the steps of: monitoring heart rate of a subject just prior to image acquisition to acquire a time period of an R-R interval; recording the time period from the heart rate monitoring to prospectively estimate future R-R intervals; and acquiring n sets of MR data, a first MR data acquisition commencing at any point in an R-R interval and extending for the time period recorded.
- [c2] 2. The method of claim 1 further comprising the steps of segmenting each

 MR data acquisition into n segments and repetitively acquiring each segment
 in n successive heartbeats.
- [c3] 3. The method of claim 2 further comprising the step of combining the n MR data sets to form a set of MR images with high temporal resolution covering the R-R interval.
- [c4] 4. The method of claim 1 further comprising the step of discontinuing heart rate monitoring before acquiring MR image data.
- [c5] 5. The method of claim 1 wherein a second set of MR data is acquired immediately after the acquisition of the first set of MR data.
- [c6] 6. The method of claim 2 wherein n=1 for fluoroscopy imaging.
- [c7] 7. The method of claim 1 wherein the step of acquiring MR data is performed using one of a fast gradient-recalled echo pulse sequence and a steady state free precession pulse sequence.
- [c8]
 8. The method of claim 1 further comprising the steps of:
 subjecting a patient to successively increased, graded levels of cardiac stress
 during the monitoring step until the heart rate is stabilized at a required
 stress level; and
 acquiring MR data according to the acquisition step of several long and short
 axis views of at least a portion of a heart muscle to monitor cardiac function





during any portion of a stress test.

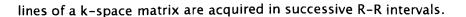
- [c9] 9. The method of claim 8 wherein the cardiac stress is induced either by physical stress or administration of a pharmaceutical.
- [c10] 10. A computer program for use with an MRI scanner having a computer, the computer program having a set of instruction that, when executed, cause the computer to:

 receive a time-period signal indicative of an R-R interval representing a cardiac cycle of a patient;

 acquire a first set of partial MR image data during a first acquisition period equal to the R-R interval;

 acquire a second set of partial MR image data during a second acquisition period equal to the R-R interval; and reconstruct an MR image by combining the first set of partial MR image data with the second set of partial MR image data.
- [c11] 11. The computer program of claim 10 having further instructions to acquire n sets of partial MR image data, each frame of data in a partial MR data set being acquired at a similar time of a corresponding frame of data in each partial MR data set during the R-R interval.
- [c12] 12. The computer program of claim 10 wherein the acquisition of MR data is not gated to an ECG trigger.
- [c13] 13. The computer program of claim 10 wherein the acquisition of each set of partial MR data is acquired at a time irrespective of either one of an R-R interval start and end.
- [c14] 14. The computer program of claim 10 wherein each portion of MR data is a segment of an MR data set.
- [c15] 15. The computer program of claim 10 wherein one-half of k-space image data for a given segment is acquired during each R-R time period.
- [c16] 16. The computer program of claim 10 wherein even and odd numbered





- [c17] 17. The computer program of claim 10 having further instructions to monitor heart rate and generate an R-R time period indicative of a current R-R interval in a patient while the MR scanner is idle.
- [c18] 18. The computer program of claim 10 having further instructions to periodically monitor heart rate and generate an R-R time period before and after each acquisition of MR data and not during any acquisition of MR data.
- [c19] 19. An MRI apparatus to acquire high-temporal resolution images comprising:

a magnetic resonance imaging (MRI) system having a plurality of gradient coils positioned about a bore of a magnet to impress a polarizing magnetic field and an RF transceiver system and an RF switch controlled by a pulse module to transmit RF signals to an RF coil assembly to acquire MR images; and

a computer programmed to:

monitor heart rate of a patient;

acquire a time period of an R-R interval of the heart rate;

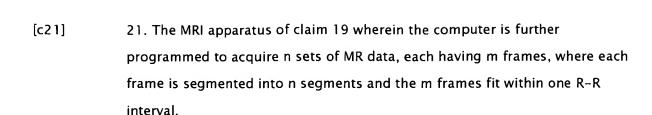
store the time period of the R-R interval;

enable the MRI system and begin an MR scan of the patient at an arbitrary time in the R-R interval;

continue to acquire MR data for a time comparable to the time period stored; and

reconstruct an MR image with the MR data acquired over at least one R-R interval as estimated by the time period stored.

[c20] 20. The MRI apparatus of claim 19 wherein the computer is further programmed to:
segment data acquisition such that a portion of data is acquired during each acquisition; and combine the segmented data acquired to reconstruct the MR image.



- [c22] 22. The MRI apparatus of claim 19 wherein the computer is further programmed to apply one of a fast gradient-recalled echo pulse sequence and a steady state free precession pulse sequence.
- [c23] 23. The MRI apparatus of claim 19 wherein the computer is further programmed to acquire one-half of k-space image data for a given segment during each R-R time period.
- [c24] 24. The MRI apparatus of claim 19 wherein the computer is further programmed to acquire even and odd numbered lines of a k-space matrix in successive R-R intervals.
- [c25] 25. An examination method comprising the steps of:
 subjecting a patient to successively increasing levels of cardiac stress;
 monitoring heart rate;
 once the heart rate is stabilized at a desired stress level, recording a time period of an R-R interval;
 acquiring non-gated MR data using the time period recorded to estimate R-R intervals.
- [c26] 26. The examination method of claim 25 wherein the cardiac stress is induced by one of either physical exercise or administration of a pharmaceutical.
- [c27] 27. The examination method of claim 25 wherein the step of acquiring MR data includes acquiring segments of each frame of data over successive R-R intervals.
- [c28]

 28. The examination method of claim 25 further comprising the step of combining the segments for each frame to reconstruct an image with high-

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